has presently innumerable *Rhinomugil*. Although this situation has not developed here, it is imperative to start preventive measures to protect indigenous species from being eliminated by competition for food and space.

The fish has good culinary value, but its commercial exploitation is not feasible in the present conditions as it escapes netting due to its ability to see out of water. Gill and cast nets have not given promising results. It is quite possible that this fish might have been accidentally introduced together with the carp frys in other major rivers of Maharashtra State. Further surveys are in progress.

WESTERN REGIONAL STATION,
ZOOLOGICAL SURVEY OF INDIA,
933/A, SHIVAJINAGAR,
PUNE-411 016,
October 20, 1983.

ACKNOWLEDGEMENTS

We are thankful to Dr. B. K. Tikader, Director, Zoological Survey of India, Calcutta for allowing us to publish this note. We are also wish to express our thanks to Dr. A. G. K. Menon for his help and advice. We are also grateful to Dr. K. C. Jayaram, Joint Director, Zoological Survey of India, Calcutta, for confirming the identification and also for critically going through the MS. Thanks are also due to the Pune regional office of Maharashtra State Fisheries Department for their help.

M. S. PRADHAN
D. F. SINGH

REFERENCES

DAY, F. (1889): The Fishes of India, William Dawson, London.

HAMILTON, F. (1822): An account of fishes found in the river Ganges and its branches, London.

JAYARAM, K. C. (1981): The Freshwater Fishes of India-A Handbook. Z.S.I., Calcutta.

MENON, A. G. K. & JAYARAM, K. C. (1977): The freshwater grey mullet *Rhinomugil corsula* (Hamilton) as a fishery resource in the Cauvery river system, South India. *Science and Culture 43*(7): 302-304.

RANGANATHAN, V. & NATARAJAN, V. (1969): Studies on the occurrence and biology of *Rhinomugil corsula* Hamilton in Krishnagiri and Sathanur reservoir, T.N. *J. Bombay nat. Hist. Soc. 66*(3): 518-532.

20. PRELIMINARY OBSERVATIONS ON THE MIGRATORY BEHAVIOUR OF THE GARHWAL HIMALAYAN MAHSEER

(*With a text-figure*)

The observations revealed a peculiar pattern of migration in the Garhwal Himalayan mahseer *Tor putitora* (Ham.). The parent population was observed to inhabit the Ganga at the foothills of the Garhwal Himalaya while new recruits and the young fish inhabit the shallow spring-fed hill streams of this region. The fish was observed to frequent snow-fed streams or rivers for a span of 3-4 months i.e. between March-April and June-July, from where the brooders moved towards suitable spawning grounds and the non-brooders re-

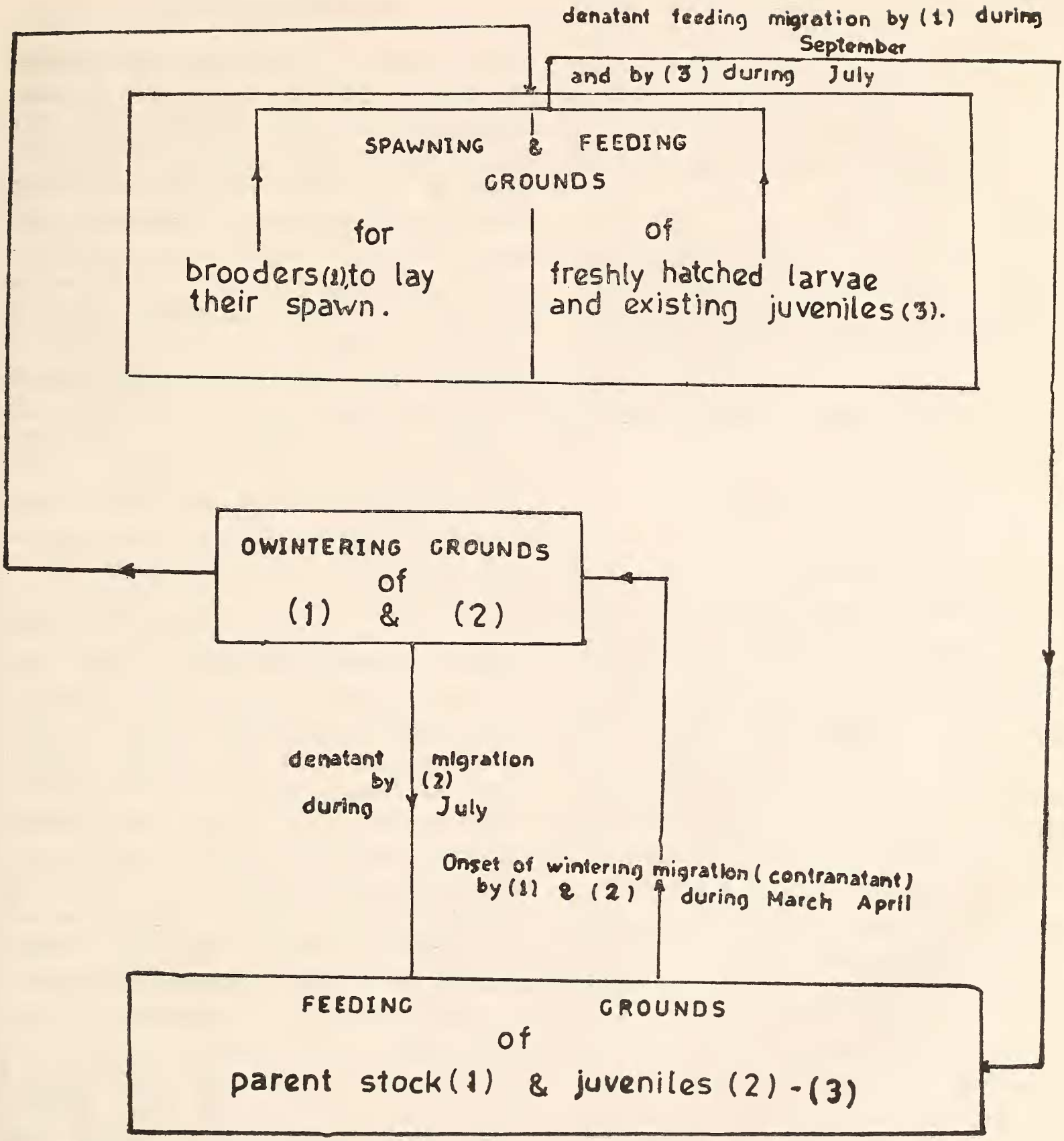

Fig. 1. Diagrammatic representation of the migratory pattern exhibited by the Garhwal Himalayan mahseer.

turned to the foothills during July. The mature fish returned to the foothills only after laying their spawn. This descent was observed during September. The earlier part was considered to be wintering migration while latter as spawning migration. The fish thus exhibited tri-phased migration.

Further, it was found to possess separate feeding, breeding and overwintering grounds, and migrates from one to another to ensure the survival of the species by maintaining the food supply. The water temperature was observed to govern the phenomenon of tri-phased migration, high turbidity being a critical factor.

Introduction

Feeding and breeding are the two most important activities while migration, in some species of fishes is an adaptation which usually links them and ensures their existence, survival and numbers. Naturally, migrations like any other adaptive property of the species, have developed in the process of evolution and the basic factor, primarily for the freshwater fishes being insufficient food supply (Nikolskii 1963). According to Nikolaev (1958 a & 1958b) and Nikolskii (1961a & b), the food supply of the parent population determines not only the fecundity but also the quality of the sexual products and thus the viability of the off-springs. Evidently, if both the parents and their young ones have same feeding grounds the competition for food will increase and lead to scarcity of food and ultimately to decrease in fecundity and viability of the off-springs.

[1] *Tor putitora* matures in four stages, 'Immature' (Ist), 'Maturing virgins' (IInd), 'Ripening' (IIIrd) and 'Ripe' (IVth).

Migratory Pattern

The parent population of the Garhwal Himalayan mahseer along with the juveniles nearing maturity inhabit the Ganga where they feed, grow and attain maturity. The phenomenon of contranatant migration commences somewhere in March-April when their shoals appear for the first time in the snow-fed tributaries of the Ganga (Fig. 1). The fishes within 20.0-70.0 cm range, comprising mainly of individuals in second and third stages of maturity[1], were in abundance while those in fourth stage of maturity were very rare. They frequented these tributaries upto June-July, thus covering a span of 3-4 months.

The first phase of migration comes to an end during July and the second phase sets in which bifurcates at this juncture. In the first part of the second phase the mahseer juveniles, which are common inhabitants of the shallow spring-fed hillstreams, move into torrential snow-fed rivers or streams when the former swell due to sudden influx of water during early monsoon. Most of them measure below 20.0 cm in length and occur almost regularly in the daily catches. They join the shoals of juveniles which had migrated upwards, and migrate along with them towards the foothills. The fact that the Ganga is a vast water body providing an appropriate environment for the young to grow and attain adolescence, as compared to the shallow streams which supplement the descent of 'immatures' into the snow-fed rivers like Alaknanda and Bhagirathi and then into the Ganga. Simultaneous to the migration of the juvenile stock commences the movement of the brooders from the Ganga and its snow-fed tributaries into the spring-fed streams possessing suitable spawning grounds. The latter were also observed to serve as the feeding grounds of the new

recruits and youngest juveniles. With the onset of the spawning season sets in the second part of the second phase of migration. This spawning migration is initiated somewhere in July and continues upto September after which the spent fishes exhibit denatant migration and return to the foothills. This, of course is the third and the concluding phase of the migration.

Factors influencing migration:

It is evident from the above observations that the fish exhibits two types of migration. Based on the purpose of migration they can be classified as 'spawning' and 'wintering'. Both of them are regulated or rather influenced by changes in the water temperature for the onset of wintering migration coincided with the general rise in the temperature. The water temperature in the Alaknanda was observed to achieve a maxima during May (18°C) which implies that the temperature in Ganga must be higher to the extent that mahseer cannot withstand it. Similarly, the denatant migration of the juveniles during July coincided with the lowering of the water temperature in the Alaknanda. Naturally, they cannot tolerate high temperatures of the Ganga and move towards cold waters of the Alaknanda and Bhagirathi, nor can they tolerate low temperatures of these snow-fed rivers and move towards warm waters of the Ganga. The fish is apparently 'sternothermal' in nature, as is *S. richardsonii,* another coldwater species of this region (Nautiyal *et al.* 1982).

The spawning migration, too, is influenced by fluctuations in the water temperature but sudden influx of the water carrying huge amounts of silt seems to be the major factor effecting migration of the brooders.

Adaptive significance

All the phases of migration are of adaptive significance. To begin with, the spawning migration ensures the survival of the species by maintaining the food supply in these rivers and streams. The migration of the 'immatures' from the spring-fed tributaries to snow-fed and that of wintering juveniles from the foothills to the upper reaches and back, too, is undertaken to maintain the food supply, which is scarce in these tributaries. In case of those which move away from the spawning-cum-feeding grounds it ensures food for new recruits which are voracious feeders (Nautiyal & Lal, in press). The tri-phased migration of the Garhwal Himalayan mahseer is obviously due to insufficient 'basic food'.

Apparently, the pattern of migration involves movement of the mahseer from the feeding grounds to the wintering ones and then to the spawning grounds. Since the upper reaches of the Ganga and its tributaries are not rich in 'basic food', the migration of *Tor putitora* is of adaptive significance from the viewpoint of limited food supply.

FISHERY BIOLOGY RESEARCH LABORATORY,
DEPARTMENT OF ZOOLOGY,
GARHWAL UNIVERSITY,
SRINAGAR-246 174, (INDIA).
July 13, 1983.

PRAKASH NAUTIYAL
M. S. LAL